ENERGY STAR®
Product Specification for Imaging Equipment

Eligibility Criteria
Final Draft Version 2.0

Following is the Version 2.0 ENERGY STAR Product Specification for Imaging Equipment. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1 DEFINITIONS

A) Product Types:

1) Printer: A product whose primary function is to generate paper output from electronic input. A printer is capable of receiving information from single-user or networked computers, or other input devices (e.g., digital cameras). This definition is intended to cover products that are marketed as printers, and printers that can be field-upgraded to meet the definition of an MFD.

2) Scanner: A product whose primary function is to convert paper originals into electronic images that can be stored, edited, converted, or transmitted, primarily in a personal computing environment. This definition is intended to cover products that are marketed as scanners.

3) Copier: A product whose sole function is to produce paper duplicates from paper originals. This definition is intended to cover products that are marketed as copiers, and upgradeable digital copiers (UDCs).

4) Facsimile (Fax) Machine: A product whose primary functions are (1) to scan paper originals for electronic transmission to remote units, and (2) to receive electronic transmissions for conversion to paper output. A fax machine may also be capable of producing paper duplicates. Electronic transmission is primarily over a public telephone system, but may also be via a computer network or the Internet. This definition is intended to cover products that are marketed as fax machines.

5) Multifunction Device (MFD): A product that performs two or more of the core functions of a Printer, Scanner, Copier, or Fax Machine. An MFD may have a physically integrated form factor, or it may consist of a combination of functionally integrated components. MFD copy functionality is considered to be distinct from single-sheet convenience copying functionality sometimes offered by fax machines. This definition includes products marketed as MFDs, and “multi-function products” (MFPs).

6) Digital Duplicator: A product sold as a fully-automated duplicator system through the method of stencil duplicating with digital reproduction functionality. This definition is intended to cover products that are marketed as digital duplicators.

7) Mailing Machine: A product whose primary function is to print postage onto mail pieces. This definition is intended to cover products that are marketed as mailing machines.

B) Marking Technologies:

1) Direct Thermal (DT): A marking technology characterized by the burning of dots onto coated print media that is passed over a heated print head. DT products do not use ribbons.

2) Dye Sublimation (DS): A marking technology characterized by the deposition (sublimation) of dye onto print media as energy is supplied to heating elements.

3) Electro-photographic (EP): A marking technology characterized by the illumination of a photoconductor in a pattern representing the desired output image via a light source, development of the image with particles of toner using the latent image on the photoconductor to define the presence or absence of toner at a given location, transfer of the toner to the final print media, and fusing to cause the output to become durable. For purposes of this specification, Color EP products simultaneously offer three or more unique toner colors, while Monochrome EP products simultaneously offer one or two unique toner colors. This definition includes Laser, Light Emitting Diode (LED), and Liquid Crystal Display (LCD) illumination technologies.

4) Impact: A marking technology characterized by the formation of the desired output image by transferring colorant from a "ribbon" to the print media via an impact process. This definition includes Dot Formed Impact and Fully Formed Impact.

5) Ink Jet (IJ): A marking technology characterized by the deposition of colorant in small drops directly to the print media in a matrix manner. For purposes of this specification, Color IJ products offer two or more unique colorants at one time, while Monochrome IJ products offer one colorant at a time. This definition includes Piezo-electric (PE) IJ, IJ Sublimation, and Thermal IJ. This definition does not include High Performance IJ.

6) High Performance IJ: An IJ marking technology that includes nozzle arrays that span the width of a page and/or the ability to dry ink on the print media via supplemental media heating mechanisms. High-performance IJ products are used in business applications usually served by electro-photographic marking products.

7) Solid Ink (SI): A marking technology characterized by ink that is solid at room temperature and liquid when heated to the jetting temperature. This definition includes both direct transfer and offset transfer via an intermediate drum or belt.

8) Stencil: A marking technology characterized by the transfer of images onto print media from a stencil that is fitted around an inked drum.

9) Thermal Transfer (TT): A marking technology characterized by the deposition of small drops of solid colorant (usually colored waxes) in a melted/fluid state directly to print media in a matrix manner. TT is distinguished from IJ in that the ink is solid at room temperature and is made fluid by heat.

C) Operational Modes:

1) On Mode:

a) Active State: The power state in which a product is connected to a power source and is actively producing output, as well as performing any of its other primary functions.

b) Ready State: The power state in which a product is not producing output, has reached operating conditions, has not yet entered into any lower-power Modes, and can enter Active State with minimal delay. All product features can be enabled in this state, and the product is able to return to Active State by responding to any potential inputs, including external electrical stimulus (e.g., network stimulus, fax call, or remote control) and direct physical intervention (e.g., activating a physical switch or button).

2) Off Mode: The power state that the product enters when it has been manually or automatically switched off but is still plugged in and connected to the mains. This mode is exited when stimulated by an input, such as a manual power switch or clock timer to bring the unit into Ready State. When this state is resultant from a manual intervention by a user, it is often referred to as Manual Off, and when it is resultant from an automatic or predetermined stimuli (e.g., a delay time or clock), it is often referred to as Auto-off.[1]

3) Sleep Mode: A reduced power state that a product enters either automatically after a period of inactivity (i.e., Default Delay Time), in response to user manual action (e.g., at a user-set time of day, in response to a user activation of a physical switch or button), or in response to external electrical stimulus (e.g., network stimulus, fax call, remote control). For products evaluated under the TEC test method, Sleep Mode permits operation of all product features (including maintenance of network connectivity), albeit with a possible delay to transition into Active State. For products evaluated under the OM test method, Sleep Mode permits operation of a single active network interface, as well as a fax connection if applicable, albeit with a possible delay to transition into Active State.

4) Standby: The lowest power consumption state which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the product is connected to the main electricity supply and used in accordance with the manufacturer's instructions.[1,2] Standby is the product's minimum power state. For Imaging Equipment products addressed by this specification, the "Standby" Mode usually corresponds to Off Mode, but may correspond to Ready State or Sleep Mode. A product cannot exit Standby and reach a lower power state unless it is physically disconnected from the main electricity supply as a result of manual manipulation.

D) Media Format:

1) Large Format: Products designed for A2 media and larger, including those designed to accommodate continuous-form media greater than or equal to 406 mm wide. Large-format products may also be capable of printing on standard-size or small-format media.

2) Standard Format: Products designed for standard-sized media (e.g., Letter, Legal, Ledger, A3, A4, B4), including those designed to accommodate continuous-form media between 210 mm and 406 mm wide. Standard-size products may also be capable of printing on small-format media.

3) Small Format: Products designed for media sizes smaller than those defined as Standard (e.g., A6, 4"x6", microfilm), including those designed to accommodate continuous-form media less than 210 mm wide.

4) Continuous Form: Products that do not use a cut-sheet media format and that are designed for applications such as printing of bar codes, labels, receipts, banners, and engineering drawings. Continuous form products can be of small, standard, or large format.

E) Additional Terms:

1) Automatic Duplexing: The capability of a copier, fax machine, MFD, or printer to produce images on both sides of an output sheet, without manual manipulation of output as an intermediate step. A product is considered to have automatic duplexing capability only if all accessories needed to produce duplex output are included with the product upon shipment.

2) Data Connection: A connection that permits the exchange of information between the imaging product and one external powered device or storage medium.

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1 For the purposes of this specification "mains" or the "main electricity supply" refers to the input power source, including a dc power supply for products that operate solely off dc power.
2 IEC 62301 Ed. 1.0 – Household electrical appliances – Measurement of standby power.

3) Default Delay Time: The time set by the manufacturer prior to shipping that determines when the product will enter a lower-power Mode (e.g., Sleep, Auto-off) following completion of its primary function.

4) Digital Front-end (DFE): A functionally-integrated server that hosts other computers and applications and acts as an interface to imaging equipment. A DFE provides greater functionality to the imaging product.

a) A DFE offers three or more of the following advanced features:

i. Network connectivity in various environments;
ii. Mailbox functionality;
iii. Job queue management;
iv. Machine management (e.g., waking the imaging equipment from a reduced power state);
v. Advanced graphic user-interface (UI);
vi. Ability to initiate communication with other host servers and client computers (e.g., scanning to email, polling remote mailboxes for jobs); or
vii. Ability to post-process pages (e.g., reformatting pages prior to printing).

b) Type 1 DFE: A DFE that draws its dc power from its own ac power supply (internal or external), which is separate from the power supply that powers the imaging equipment. This DFE may draw its ac power directly from a wall outlet, or it may draw it from the ac power associated with the imaging product's internal power supply. A Type 1 DFE may be sold standard with the Imaging Equipment product, or as an optional accessory.

Note: EPA has clarified the Type 1 definition to indicate that Type 1 DFEs sold with or as an option with the Imaging Equipment product at the time of purchase must meet DFE_{TEC} requirements in order for the associated Imaging Equipment product to qualify.

c) Type 2 DFE: A DFE that draws its dc power from the same power supply as the imaging equipment with which it operates. Type 2 DFEs must have a board or assembly with a separate processing unit that is capable of initiating activity over the network and can be physically removed, isolated, or disabled using common engineering practices to allow power measurements to be made.

d) Auxiliary Processing Accelerator (APA): A computing expansion add-in card installed in a general-purpose add-in expansion slot of the DFE (e.g., GPGPU installed in a PCI slot).

Note: In response to stakeholder comments in Draft 2, EPA has provided a definition for APAs as a more general categorization variable than Graphics Processing Units (GPUs) for the TEC_{DFE} requirements in Table 2. This definition is based on the APA definition in the Version 2.0 Computer Servers specification, currently under development.

5) Network Connection: A connection that permits the exchange of information between the imaging product and one or more external powered devices.

6) Functional Adder: A data or network interface or other component that adds functionality to the marking engine of an imaging equipment product and provides a power allowance when qualifying products according to the OM method.

7) Operational Mode (OM): For the purposes of this specification, a method of comparing product energy performance via an evaluation of power (measured in watts) in various operating states, as specified in Section 9 of the ENERGY STAR Imaging Equipment test method.

8) Typical Electricity Consumption (TEC): For the purposes of this specification, a method of comparing product energy performance via an evaluation of typical electricity consumption (measured in kilowatt-hours) during normal operation over a specified period of time, as specified in Section 8 of the ENERGY STAR Imaging Equipment test method.

9) Marking Engine: The fundamental engine of an imaging product that drives image production. A marking engine relies upon functional adders for communication ability and image processing. Without functional adders and other components, a marking engine cannot acquire image data for processing and is non-functional.

10) Base Product: The most fundamental configuration of a particular Product Model, which possesses the minimum number of functional adders available. Optional components and accessories are not considered part of a base product.

11) Accessory: A piece of peripheral equipment that is not necessary for the operation of the Base Product, but that may be added before or after shipment in order to add functionality. An accessory may be sold separately under its own model number, or sold with a base product as part of a package or configuration.

12) Product Model: An imaging equipment product that is sold or marketed under a unique model number or marketing name. A product model may be comprised of a base product or a base product plus accessories.

13) Product Family: A group of product models that are (1) made by the same manufacturer, (2) subject to the same ENERGY STAR qualification criteria, and (3) of a common basic design. Product models within a family differ from each other according to one or more characteristics or features that either (1) have no impact on product performance with regard to ENERGY STAR qualification criteria, or (2) are specified herein as acceptable variations within a product family. For Imaging Equipment, acceptable variations within a product family include:

    a) Color,

    b) Housing,

    c) Input or output paper-handling accessories,

    d) Electronic components not associated with the marking engine of the Imaging Equipment product.

Note: EPA received comments that EPA should retain “input voltage and frequency” on the list of allowable family variations even though doing so would increase testing and certification burden for products sold internationally. Since only products sold in the US are required to be third party certified, testing should not increase for these products. If products are sold in the US with different frequencies and voltages, the energy performance of these products is expected to change and thus they should be tested and qualified separately.

As was noted in Draft 2, EPA has expanded the scope of allowable variation within a product family to include electronic components that are not associated with the marking engine of the Imaging Equipment product. Products are tested and qualified with the most featured and highest energy using configuration within a family and any changes or additions of electronic components in the system that lead to greater power consumption than the qualified representative model will require requalification.

2 SCOPE

2.1 Included Products

2.1.1 Commercially-available products that meet one of the Imaging Equipment definitions in Section 1.A) and are capable of being powered from (1) a wall outlet, (2) a data or network connection, or (3) both a wall outlet and a data or network connection, are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.2.

2.1.2 An imaging equipment product must further be classified as either "TEC" or "OM" in Table 1, below, depending on the method of ENERGY STAR evaluation.

Table 1: Evaluation Methods for Imaging Equipment

Equipment Type	Media Format	Marking Technology	ENERGY STAR Evaluation Method
Copier	Standard	DT, DS, EP, SI, TT	TEC
	Large	DT, DS, EP, SI, TT	OM
Digital Duplicator	Standard	Stencil	TEC
Fax Machine	Standard	DT, DS, EP, SI, TT	TEC
		IJ	OM
Mailing Machine	All	DT, EP, IJ, TT	OM
Multifunction Device (MFD)	Standard	High Performance IJ, DT, DS, EP, SI, TT	TEC
		IJ, Impact	OM
	Large	DT, DS, EP, IJ, SI, TT	OM
Printer	Standard	High Performance IJ, DT, DS, EP, SI, TT	TEC
		IJ, Impact	OM
	Large or Small	DT, DS, EP, Impact, IJ, SI, TT	OM
	Small	High Performance IJ	TEC
Scanner	All	N/A	OM

2.2 Excluded Products

2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for qualification under this specification. The list of specifications currently in effect can be found at www.energystar.gov/products.

2.2.2 Products that satisfy one or more of the following conditions are not eligible for ENERGY STAR qualification under this specification:

i. Products that are designed to operate directly on three-phase power.
ii. Products sold with multiple DFEs.

Note: Based on stakeholder comments**,** EPA has excluded Imaging Equipment products sold with multiple DFEs from the scope due to a lack of information on the prevalence of these products in the marketplace and clear understanding of the effect of using two DFEs on energy consumption. EPA is interested information on the prevalence of products in the market and the energy performance of this configuration to determine if they should be included in scope in future specifications.

3 QUALIFICATION CRITERIA

3.1 Significant Digits and Rounding

3.1.1 All calculations shall be carried out with directly measured (unrounded) values.

3.1.2 Unless otherwise specified, compliance with specification limits shall be evaluated using directly measured or calculated values without any benefit from rounding.

3.1.3 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.

3.2 General Requirements

3.2.1 External Power Supply (EPS):

i. If the product is shipped with a single-voltage EPS, the EPS shall meet the level V performance requirements under the International Efficiency Marking Protocol and include the level V marking. Additional information on the Marking Protocol is available at www.energystar.gov/powersupplies.

- Single-output EPS shall meet level V requirements when tested using the *Test Method for Calculating the Energy Efficiency of Single-Voltage External Ac-Dc and Ac-Ac Power Supplies*, Aug. 11, 2004.

- Multi-output EPS shall meet the level V requirements when tested using the *EPRI 306 Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.6.* Power Supply data generated using Rev. 6.4.2 (as required in Version 1.2) is acceptable provided the test was conducted prior to the effective date of Version 2.0.

3.2.2 Additional Cordless Handset: Fax machines and MFDs with fax capability that are sold with additional cordless handsets shall use an ENERGY STAR qualified handset, or one that meets the ENERGY STAR Telephony specification when tested to the ENERGY STAR test method on the date the imaging product is qualified as ENERGY STAR. The ENERGY STAR specification and test method for telephony products may be found at www.energystar.gov/products.

3.2.3 Functionally Integrated MFD: If an MFD consists of a set of functionally integrated components (i.e., the MFD is not a single physical device), the sum of the measured energy or power consumption for all components shall be less than the relevant MFD energy or power consumption requirements for ENERGY STAR qualification.

3.2.4 DFE Requirements: The Typical Electricity Consumption of a Type 1 or Type 2 DFE sold with an Imaging Equipment product (TEC_{DFE}) shall be calculated using Equation 1 for a DFE without sleep mode or Equation 2 for a DFE with sleep mode. The resulting TEC_{DFE} value shall be less than or equal to the maximum TEC_{DFE} requirement specified in Table 2 for the given DFE type.

i. The TEC value or ready mode power of a DFE that meets the maximum TEC_{DFE} requirements should be excluded or subtracted from the TEC energy and OM power measurements of the Imaging Equipment product as appropriate.
ii. Section 3.3.2i provides further detail on subtracting TEC_{DFE} values from TEC products;
iii. Section 3.4.2 provides further detail for excluding DFEs from OM Sleep and Standby levels.

Equation 1: TEC_{DFE} Calculation for Digital Front Ends without Sleep Mode

$$TEC_{DFE} = \frac{168 \times P_{DFE\_READY}}{1000}$$

Where:

- *TEC_{DFE} is the typical weekly energy consumption for DFEs, expressed in kilowatt-hours (kWh) and rounded to the nearest 0.1 kWh;*
- *P_{DFE_READY} is ready mode power measured in the test procedure in watts.*

Equation 2: TEC_{DFE} Calculation for Digital Front Ends with Sleep Mode

$$TEC_{DFE} = \frac{(45 \times P_{DFE\_READY}) + (123 \times P_{DFE\_SLEEP})}{1000}$$

Where:

- *TEC_{DFE} is the typical weekly energy consumption for DFEs, expressed in kilowatt-hours (kWh) and rounded to the nearest 0.1 kWh;*
- *P_{DFE_READY} is ready mode power measured in the test procedure in watts.*
- *P_{DFE_SLEEP} is sleep mode power measured in the test procedure in watts.*

Table 2: Maximum TEC_{DFE} Requirements for Type 1 and Type 2 DFEs

DFE Category	Category Description	Maximum TEC_{DFE} (kWh/week, rounded to the nearest 0.1 kWh/week for reporting)	
		Type 1 DFE	Type 2 DFE
A	All DFEs that do not meet the definition of Category B will be considered under Category A for ENERGY STAR qualification.	10.9	8.7
B	To qualify under Category B DFEs must have: 2 or more physical CPUs or 1 CPU and ≥ 1 discrete Auxiliary Processing Accelerators (APAs)	22.7	18.2

Note: Based on analysis of data received from stakeholders, EPA is proposing to use an 80% power supply efficiency assumption for the calculation of Type 2 DFE TEC_{DFE} requirements in the Final Draft. When DFE Ready Mode is measured in the test method, the Imaging Equipment product is required to be in Ready Mode as well. Stakeholder submitted data shows that power supplies operate at or slightly above 80% efficiency when both the DFE and Imaging Equipment product are in Ready Mode. The revised Type 2 DFE TEC_{DFE} values, calculated using this revised efficiency assumption, are shown in Table 2 above.

3.3 Requirements for Typical Electricity Consumption (TEC) Products

3.3.1 Automatic Duplexing Capability:

i. For all copiers, MFDs, and printers subject to the TEC test method, automatic duplexing capability shall be present at the time of purchase as specified in Table 3 and Table 4. Printers whose intended function is to print on special single-sided media for the purpose of single sided printing (e.g. release coated paper for labels, direct thermal media, etc.,) are exempt from 3.3.1.

Table 3: Automatic Duplexing Requirements for all Monochrome TEC Copiers, MFDs, and Printers

Monochrome Product Speed, *s*, as Calculated in the Test Method (ipm)	Automatic Duplexing Requirement
$s \leq 19$	None
$19 < s < 35$	Integral to the base product or optional accessory
$s \geq 35$	Integral to the base product

Table 4: Automatic Duplexing Requirements for all Color TEC Copiers, MFDs, and Printers

Monochrome Product Speed, *s*, as Calculated in the Test Method (ipm)	Automatic Duplexing Requirement
$s \leq 24$	None
$24 < s < 37$	Integral to the base product or optional accessory
$s \geq 37$	Integral to the base product

ii. If a product is not certain to be bundled with an automatic duplex tray, the partner must make clear in their product literature, on their Web site, and in institutional sales literature that although the product meets the ENERGY STAR energy efficiency requirements, the product only fully qualifies for ENERGY STAR when bundled with or used with a duplexer tray. EPA asks that partners use the following language to convey this message to customers: "Achieves ENERGY STAR energy savings; product fully qualifies when packaged with (or used with) a duplex tray."

Note: In Draft 2, EPA attempted to unify the automatic duplexing requirements for color and monochrome imaging devices. Stakeholders commented that for some lower speed products, automatic duplexing is not practical and may have the potential effect of discouraging lower-cost ENERGY STAR qualified printers. Stakeholders also noted that removal of the optional accessory requirement for middle speed range products was a cost issue and consumers should have the option to select this price impacting functionality. EPA recognizes these concerns and as such has revised the proposed automatic duplexing requirement to revert back to providing separate automatic duplexing requirements based on color capability and speed. Based on input from stakeholders, EPA has however increased the stringency of the requirements (compared to Version 1.2) to reflect improvements in products in the market.

EPA recognizes there are circumstances in the manufacture and distribution of base products and duplex accessories that present challenges to the ENERGY STAR labeling requirements. As such, under Version 2.0, EPA proposing to continue the allowance for ENERGY STAR labeled products to be sold without the duplex tray. The partner must, in this case, make clear in their product literature, on their Web site, and in institutional sales literature that although the product meets the ENERGY STAR energy efficiency requirements, the product only fully qualifies for ENERGY STAR when bundled with or used with a duplexer tray.

3.3.2 Typical Electricity Consumption: Calculated Typical Electricity Consumption (TEC) per Equation 3 or Equation 4 shall be less than or equal to the Maximum TEC Requirement (TEC_{MAX}) specified in Equation 6 to the nearest 0.1 kilowatt-hour.

i. For imaging products with a Type 2 DFE that meet the Type 2 DFE maximum TEC_{DFE} requirement found in Table 2, the measured energy consumption of the DFE, shall be divided by 0.80 to account for internal power supply losses, and then be excluded when comparing the product's measured TEC value to TEC_{MAX}. The DFE shall not interfere with the ability of the imaging product to enter or exit its lower-power modes. The energy use of a DFE can only be excluded if it meets the DFE definition in Section 1 and that has a separate processing unit that is capable of initiating activity over the network, may be subtracted from the measured DFE.

Example: A printer's total TEC result is 24.50 kWh/wk and its Type 2 TEC_{DFE} value calculated in Section 3.2.4 is 9.0 kWh/wk. The TEC_{DFE} value is then divided by 0.80 to account for internal power supply losses with the Imaging Equipment in Ready Mode, resulting in 11.25 kWh/wk. The power supply adjusted value is subtracted from the tested TEC value: 24.50 kWh/wk – 11.25 kWh/wk = 13.25 kWh/wk. This 13.25 kWh/wk result is then compared to the relevant TEC_{MAX} to determine qualification

Note: EPA received stakeholder feedback that dc power measured at the DFE in TEC products cannot be subtracted from the ac power at the ac mains without accounting for losses in the Imaging Equipment product's internal power supply. Applying the same assumption regarding typical internal power supply efficiency in Table 2, above, EPA proposes to divide the measured TEC_{DFE} value by 0.80 to account for internal power supply losses. EPA has revised the language in section 3.3.2 as well as the example notebox to reflect this addition.

ii. For printers, fax machines, digital duplicators with print capability, and MFDs with print capability, TEC shall be calculated per Equation 3.

Equation 3: TEC Calculation for Printers, Fax Machines, Digital Duplicators with Print Capability, and MFDs with Print Capability

$$TEC = 5 \times \left[E_{JOB\_DAILY} + (2 \times E_{FINAL}) + \left[24 - (N_{JOBS} \times 0.25) - (2 \times t_{FINAL})\right] \times \frac{E_{SLEEP}}{t_{SLEEP}} \right] + 48 \times \frac{E_{SLEEP}}{t_{SLEEP}},$$

Where:

- *TEC is the typical weekly energy consumption for printers, fax machines, digital duplicators with print capability, and MFDs with print capability, expressed in kilowatt-hours (kWh) and rounded to the nearest 0.1 kWh;*
- E_{JOB_DAILY} *is the daily job energy, as calculated per Equation 5, in kWh;*
- E_{FINAL} *is the final energy, as measured in the test procedure, converted to kWh;*
- N_{JOBS} *is the number of jobs per day, as calculated in the test procedure,*
- t_{FINAL} *is the final time to Sleep, as measured in the test procedure, converted to hours;*
- E_{SLEEP} *is the Sleep energy, as measured in the test procedure, converted to kWh; and*
- t_{SLEEP} *is the Sleep time, as measured in the test procedure, converted to hours.*

iii. For copiers, digital duplicators without print capability, and MFDs without print capability, TEC shall be calculated per Equation 4.

Equation 4: TEC Calculation for Copiers, Digital Duplicators without Print Capability, and MFDs without Print Capability

$$TEC = 5 \times \left[E_{JOB\_DAILY} + (2 \times E_{FINAL}) + \left[24 - (N_{JOBS} \times 0.25) - (2 \times t_{FINAL}) \right] \times \frac{E_{AUTO}}{t_{AUTO}} \right] + 48 \times \frac{E_{AUTO}}{t_{AUTO}},$$

Where:

- *TEC is the typical weekly energy consumption for copiers, digital duplicators without print capability, and MFDs without print capability, expressed in kilowatt-hours (kWh) and rounded to the nearest 0.1 kWh;*
- *E_{JOB_DAILY} is the daily job energy, as calculated per Equation 5, in kWh;*
- *E_{FINAL} is the final energy, as measured in the test procedure, converted to kWh;*
- *N_{JOBS} is the number of jobs per day, as calculated in the test procedure;*
- *t_{FINAL} is the final time to Sleep, as measured in the test procedure, converted to hours;*
- *E_{AUTO} is the Auto-off energy, as measured in the test procedure, converted to kWh; and*
- *t_{AUTO} is the Auto-off time, as measured in the test procedure, converted to hours.*

iv. Daily Job Energy shall be calculated per Equation 5.

Equation 5: Daily Job Energy Calculation for TEC Products

$$E_{JOB\_DAILY} = (2 \times E_{JOB1}) + \left((N_{JOBS} - 2) \times \frac{E_{JOB2} + E_{JOB3} + E_{JOB4}}{3} \right),$$

Where:

- *E_{JOB_DAILY} is the daily job energy, expressed in kilowatt-hours (kWh);*
- *E_{JOBi} is the energy of the i^{th} job, as measured in the test procedure, converted to kWh; and*
- *NJOBS is the number of jobs per day, as calculated in the test procedure.*

Equation 6: Maximum TEC Requirement Calculation

$$TEC_{MAX} = TEC_{REQ} + Adder_{A3},$$

Where:

- *TEC_{MAX} is the maximum TEC requirement in kilowatt-hours per week (kWh/wk);*
- *TEC_{REQ} is the TEC requirement specified in Table 5, in kWh; and*
- *$Adder_{A3}$ is a 0.02 kWh/wk allowance provided for A3 products with a paper path width equal to or greater than 11 inches.*

Note: Based on stakeholder feedback, EPA conducted an analysis on the impact of A3 versus A4 paper width on printers qualification rates. EPA did find a lower qualification rate among products using A3 paper. As such, EPA is proposing an adder of 0.20 kWh/week for A3 paper width products to ensure adequate selection.

Table 5: TEC Requirement Before A3 Allowance (If Applicable)

Color Capability	Monochrome Product Speed, *s*, as Calculated in the Test Method (ipm)	TEC_{REQ} (kWh/week, to the nearest 0.1 kWh/week for reporting)
Monochrome Non-MFD	$s \leq 5$	0.3
	$5 < s \leq 20$	(**s** x 0.04) + 0.1
	$20 < s \leq 30$	(**s** x 0.06) – 0.3
	$30 < s \leq 40$	(**s** x 0.11) – 1.8
	$40 < s \leq 65$	(**s** x 0.16) – 3.8
	$65 < s \leq 90$	(**s** x 0.2) – 6.4
	$s > 90$	(**s** x 0.55) – 37.9
Monochrome MFD	$s \leq 5$	0.4
	$5 < s \leq 30$	(**s** x 0.07) + 0.05
	$30 < s \leq 50$	(**s** x 0.11) – 1.15
	$50 < s \leq 80$	(**s** x 0.25) – 8.15
	$s > 80$	(**s** x 0.6) – 36.15
Color Non-MFD	$s \leq 10$	1.3
	$10 < s \leq 15$	(**s** x 0.06) + 0.7
	$15 < s \leq 30$	(**s** x 0.15) – 0.65
	$30 < s \leq 75$	(**s** x 0.2) – 2.15
	$s > 75$	(**s** x 0.7) – 39.65
Color MFD	$s \leq 10$	1.5
	$10 < s \leq 15$	(**s** x 0.1) + 0.5
	$15 < s \leq 30$	(**s** x 0.13) + 0.05
	$30 < s \leq 70$	(**s** x 0.2) – 2.05
	$70 < s \leq 80$	(**s** x 0.7) – 37.05
	$s > 80$	(**s** x 0.75) – 41.05

Note: Based on stakeholder feedback, EPA has reviewed the data set and removed duplicates and data with errors to ensure we are using the most accurate information to create the appropriate efficiency criteria across all product categories. The resulting data set did not significantly alter the qualification rate using the Draft 2 proposed TEC max but EPA made some minor adjustments to the monochrome non-MFD lower speed products to allow a modest increase in the products eligible for certification. The adjustments to proposed levels reflect qualified data up through September 20, 2012. EPA analyzed the impact of these new levels on each TEC category.

At the proposed TEC levels for the four product classes, EPA expects a broad selection of models from multiple manufacturers to be eligible for the ENERGY STAR. EPA is proposing levels that recognize uncertainty around the revised test method.

3.3.3 Additional Test Results Reporting Requirements: Recovery times from various modes (Active 0, Active 1, Active 2 times) and Default Delay Time shall be reported for all products tested using the TEC test method.

Note: Since recovery time and Default Delay Time to Sleep are useful to consumers and potentially a useful parameter for evaluating the impact of the Version 2.0 requirements on usability, EPA proposes to require reporting them for all TEC products. To provide a recovery time metric that is meaningful to the user, EPA proposes averaging Active 0, Active 1, and Active 2 times, and reporting their unweighted arithmetic mean on the Version 2.0 Qualified Product List (QPL). Although EPA considered weighting the Active times according to the frequency with which they are encountered throughout the day, doing so could obscure the importance that users attach to shorter recovery times from low-power modes (Active 0 and Active 1 times). The unweighted average gives these recovery times equal prominence and is a simple, easy-to-understand calculation.

3.4 Requirements for Operational Mode (OM) Products

3.4.1 Multiple Sleep Modes: If a product is capable of automatically entering multiple successive Sleep Modes, the same Sleep Mode shall be used to determine qualification under the default delay time to sleep requirements specified in Section 3.4.2 and the Sleep Mode power consumption requirements specified in Section 3.4.3.

3.4.2 DFE Requirements: For imaging products with a functionally-integrated DFE that relies on the imaging product for its power, and that meets the appropriate maximum TEC_{DFE} requirement found in Table 2, the ready mode power of the DFE, measured in the test method, should be divided by 0.60 to account for internal power supply losses, and then excluded when comparing the product's measured Sleep Mode power to the combined marking-engine and functional-adder criteria limits below and when comparing the measured Standby Mode power to the Standby criteria limits below.

i. The DFE must not interfere with the ability of the imaging product to enter or exit its lower-power modes.
ii. In order to take advantage of this exclusion, the DFE must meet the definition in Section 1 and be a separate processing unit that is capable of initiating activity over the network.

Note: Stakeholders noted that the Draft 2 assumption of 85% power supply efficiency for the Type 2 DFE used in large format OM products was too high. No products currently in the market would be able to meet both the marking engine sleep values and the maximum TEC_{DFE} requirements. Stakeholders stated that power supplies operate at a significantly lower efficiency when the Imaging Equipment product is in Sleep Mode, which is the case during OM testing.

EPA has received additional feedback from stakeholders and is proposing a lower power supply efficiency assumption for OM products sold with Type 2 DFEs. When an Imaging Equipment product is in Sleep Mode, the internal power supply is operating at a significantly lower load point, resulting in power supply efficiency of approximately 60%. EPA proposes to divide the measured TEC_{DFE} value in Section 3.4.2 by 0.60, reflecting this assumption of 60% power supply efficiency with the Imaging Equipment in Sleep Mode.

3.4.2 Default Delay Time: Measured Default Delay Time to Sleep (t_{SLEEP}) shall be less than or equal to the Required Default Delay Time to Sleep (t_{SLEEP_REQ}) requirement specified in Table 6, subject to the following conditions:

i. The Default Delay Time to Sleep may not be adjusted by the user to be greater than the Maximum Machine Delay Time. This Maximum Machine Delay Time shall be set by the manufacturer at less than or equal to 4 hours.

Note: EPA received stakeholder comments that the terms associated with Default Delay Time are confusing and that some are used interchangeably in the specification. EPA has clarified the Default Delay Time to Sleep Requirement as follows:
- Default Delay Time is the measured parameter of the UUT in its as-shipped state,

- Required Default Delay Time (formerly Maximum Default Delay Time) is the value listed in Table 66 against which the measured parameter is compared to for purposes of qualification, and
- Maximum Machine Delay Time is the value also listed in the specification (4 hours for all products) beyond which the Default Delay Time cannot be extended by the end-user.

ii. When reporting data and qualifying products that can enter Sleep Mode in multiple ways, partners should reference a Sleep level that can be reached automatically. If the product is capable of automatically entering multiple, successive Sleep levels, it is at the manufacturer's discretion which of these levels is used for qualification purposes; however, the default-delay time provided must correspond with whichever level is used.

iii. Default Delay Time does not apply to OM products that can meet sleep mode requirements in ready mode.

Table 6: Required Default Delay Time to Sleep for OM Products

Product Type	Media Format	Monochrome Product Speed, ***s***, as Calculated in the Test Method (ipm or mppm)	Required Default Delay Time to Sleep, t_{SLEEP_REQ} (minutes)
Copier	Large	***s*** ≤ 30	30
		s > 30	60
Fax Machine	Small or Standard	All	5
MFD	Small or Standard	***s*** ≤ 10	15
		10 < ***s*** ≤ 20	30
		s > 20	60
	Large	***s*** ≤ 30	30
		s > 30	60
Printer	Small or Standard	***s*** ≤ 10	5
		10 < ***s*** ≤ 20	15
		20 < ***s*** ≤ 30	30
		s > 30	60
	Large	***s*** ≤ 30	30
		s > 30	60
Scanner	All	All	15
Mailing Machine	All	***s*** ≤ 50	20
		50 < ***s*** ≤ 100	30
		100 < ***s*** ≤ 150	40
		s > 150	60

3.4.3 Sleep Mode Power Consumption: Measured Sleep Mode power consumption (P_{SLEEP}) shall be less than or equal to the maximum Sleep Mode power consumption requirement (P_{SLEEP_MAX}) determined per Equation 7, subject to the following conditions:

i. Only those interfaces that are present and used during the test, including any fax interface, may be considered functional adders.
ii. Product functionality offered through a DFE shall not be considered a functional adder.
iii. A single interface that performs multiple functions may be counted only once.
iv. Any interface that meets more than one interface type definition shall be classified according to the functionality used during the test.
v. For products that meet the Sleep Mode power requirement in Ready State, no further automatic power reductions are required to meet Sleep Mode requirements.

Equation 7: Calculation of Maximum Sleep Mode Power Consumption Requirement for OM products

$$P_{SLEEP\_MAX} = P_{MAX\_BASE} + \sum_{1}^{n} Adder_{INTERFACE} + \sum_{1}^{m} Adder_{OTHER}$$

Where:

- P_{SLEEP_MAX} *is the maximum Sleep Mode power consumption requirement, expressed in watts (W), and rounded to the nearest 0.1 watt;*
- P_{MAX_BASE} *is the maximum Sleep Mode power allowance for the base marking engine, as determined per Table 7 , in watts;*
- $Adder_{INTERFACE}$ *is the power allowance for the interface functional adders used during the test, including any fax capability and as selected by the manufacturer from Table 8, in watts;*
- *n is the number of allowances claimed for interface functional adders used during the test, including any fax capability and is less than or equal to 2*
- $Adder_{OTHER}$ *is the power allowance for any non-interface functional adders in use during the test, as selected by the manufacturer from Table 8,, in watts; and*
- *m is the number of allowances claimed for any non-interface functional adders in use during the test.*

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525 **Table 7: Sleep Mode Power Allowance for Base Marking Engine**

Product Type	Media Format	Marking Technology				P_{MAX_BASE} (watts)
		Impact	Ink Jet	All Other	Not Applicable	
Copier	Large			x		8.2
Fax Machine	Standard		x			0.6
Mailing Machine	N/A		x	x		5.0
MFD	Standard	x	x			0.6
	Large		x			4.9
				x		8.2
Printer	Small	x	x	x		4.0
	Standard	x	x			0.6
	Large	x		x		2.5
			x			4.9
Scanner	Any				x	2.5

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528 **Table 8: Sleep Mode Power Allowances for Functional Adders**

Adder Type	Connection Type	Max. Data Rate, *r* (Mbit/ second)	Details	Functional Adder Allowance (watts)
Interface	Wired	r < 20	Includes: USB 1.x, IEEE 488, IEEE 1284/Parallel/ Centronics, RS232	0.2
		20 ≤ r < 500	Includes: USB 2.x, IEEE 1394/ FireWire/i.LINK, 100Mb Ethernet	0.4
		r ≥ 500	Includes: USB 3.x,1G Ethernet	0.5
		Any	Includes: Flash memory-card/smart-card readers, camera interfaces, PictBridge	0.2
	Fax Modem	Any	**Applies to Fax Machines and MFDs only.**	0.2
	Wireless, Radio-frequency (RF)	Any	Includes: Bluetooth, 802.11	2.0
	Wireless, Infrared (IR)	Any	Includes: IrDA.	0.1
Cordless Handset	N/A	N/A	Capability of the imaging product to communicate with a cordless handset. Applied only once, regardless of the number of cordless handsets the product is designed to handle. Does not address the power requirements of the cordless handset itself.	0.8

Adder Type	Connection Type	Max. Data Rate, *r* (Mbit/ second)	Details	Functional Adder Allowance (watts)
Memory	N/A	N/A	Applies to the internal capacity available in the imaging product for storing data. Applies to all volumes of internal memory and should be scaled accordingly for RAM. This adder does not apply to hard disk or flash memory.	0.5/GB
Scanner	N/A	N/A	**Applies to MFDs and Copiers only.** Includes: Cold Cathode Fluorescent Lamp (CCFL) or a technology other than CCFL, such as Light-Emitting Diode (LED), Halogen, Hot-Cathode Fluorescent Tube (HCFT), Xenon, or Tubular Fluorescent (TL) technologies. (Applied only once, regardless of the lamp size or the number of lamps/bulbs employed.)	0.5
Power Supply	N/A	N/A	Applies to both internal and external power supplies of Mailing Machines and Standard Format products using Inkjet and Impact marking technologies with nameplate output power (P_{OUT}) greater than 10 watts.	0.02 x (P_{OUT} – 10.0)
Touch Panel Display	N/A	N/A	Applies to both monochrome and color touch panel displays.	0.2
Internal Disk Drives	N/A	N/A	Includes any high-capacity storage product, including hard-disk and solid-state drives. Does not cover interfaces to external drives.	0.15

Note: EPA has further modified Table 8 to permit the application of the Power Supply adder to Mailing Machines, which, like Ink Jet printers and MFDs have higher speed and functionality correlated with the rating of the power supply.

A notebox in the Draft 2 specification made clear that the touch-panel adder would be limited to small capacitive touch panels; however, stakeholders commented that the adder should apply to all touch panel technologies and sizes. EPA does not wish to constrain this functionality, and wishes to clarify that the adder may be applied to all touch panel technologies and sizes. Additionally, EPA is requesting that touch panel type and size be reported during testing.

3.4.4 Standby Power Consumption: Standby Mode power, which is the lesser of the Ready Mode Power, Sleep Mode Power, and Off Mode Power, as measured in the test procedure, shall be less than or equal to the Maximum Standby Power specified in Table 9, subject to the following condition.

i. The Imaging Equipment shall meet the Standby Power requirement independent of the state of any other devices (e.g., a host PC) connected to it.

Table 9: Maximum Standby Power Requirement

Product Type	Maximum Standby Power (watts)
All OM Products	0.5

Note: Products intended for sale in the US market are subject to minimum toxicity and recyclability requirements. Please see ENERGY STAR Program Requirements for Imaging Equipment: Partner Commitments for details.

4 TESTING

4.1 Test Methods

4.1.1 When testing Imaging Equipment products, the test methods identified in Table 10 shall be used to determine qualification for ENERGY STAR.

Table 10: Test Methods for ENERGY STAR Qualification

Product Type	Test Method
All Products	ENERGY STAR Imaging Equipment Test Method, Rev. May-2012

4.2 Number of Units Required for Testing

4.2.1 Representative Models shall be selected for testing per the following requirements:

i. For qualification of an individual product model, a product configuration equivalent to that which is intended to be marketed and labeled as ENERGY STAR is considered the Representative Model;

ii. For qualification of a product family, the highest energy using configuration within the family shall be considered the Representative Model. When submitting product families, manufacturers continue to be held accountable for any efficiency claims made about their imaging products, including those not tested or for which data was not reported.

4.2.2 A single unit of each Representative Model shall be selected for testing.

4.3 International Market Qualification

4.3.1 Products shall be tested for qualification at the relevant input voltage/frequency combination for each market in which they will be sold and promoted as ENERGY STAR.

5 USER INTERFACE

5.1.1 Manufacturers are encouraged to design products in accordance with the user interface standard IEEE 1621: Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments. For details, see http://eetd.LBL.gov/Controls.

6 EFFECTIVE DATE

6.1.1 Effective Date: The Version 2.0 ENERGY STAR Imaging Equipment specification shall take effect on **October 1, 2013**. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on its date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.

Note: Due to extensive feedback from stakeholders following the publication of Draft 2, EPA expects to finalize the specification in January 2013, with an effective date of October 1, 2013.

6.1.2 Future Specification Revisions: EPA reserves the right to change this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through stakeholder discussions. In the event of a specification revision, please note that the ENERGY STAR qualification is not automatically granted for the life of a product model.

6.1.3 Items for Consideration in Future Revision:

i. **Network Proxy**: EPA will continue to monitor the implementation of proxying capability in imaging equipment hardware and consider the development of a test method to determine the presence of a network proxy (e.g. one compliant with ECMA-393 ProxZzzy for Sleeping Hosts).

ii. **Draft Mode**: Stakeholders raised concerns with the current method of qualifying TEC products. Specifically, assigning TEC limits based on the maximum claimed speed while testing using the default speed. EPA and DOE have clarified the test method to avoid the confusion between the two potentially different speeds and will continue to monitor qualifying products to assess the impacts of these differences and potential test method changes in future revisions.

iii. **Recovery Time for OM Products**: EPA is interested in a recovery time requirement for OM devices and welcomes stakeholder input on the benefits of providing this data to consumers on the qualified product list. If substantial benefits exist, EPA and DOE may include a recovery time measurement for OM products in the next version of the test method.

iv. **TEC Requirements in Kilowatt-hours per Year**: EPA has added columns to the TEC Tables expressing the requirements in kilowatt-hours per year in addition to the currently-used kilowatt-hours per week. Although this is purely informative, EPA will consider making this unit the only way to express TEC in a future specification revision as a way to address issues with reporting accuracy and comparisons between other ENERGY STAR products (which typically report in kilowatt-hours/year).

v. **Consistency of speed values:** While the maximum claimed print speed is used for purposes of calculation and qualification, the as-shipped speed is used within testing to emulate the end user's expected performance. EPA is interested in measuring as-shipped speed within the test method, and using this value for qualification purposes. Possible test methods for consideration include ISO/IEC 24734:2009 Method for measuring digital printing productivity and ISO/IEC 24735:2012 Method for measuring digital copying productivity.

vi. **Wake Up Test Method**: EPA' s intent is that ENERGY STAR qualified products use power management features, in the as-shipped condition, without requiring special configurations for use on the local network. If a fully networked machine is awoken by common network events, the energy associated with these events should be captured while testing for ENERGY STAR qualification. EPA and DOE are interested in working with stakeholders to develop a test method to standardize the wake up testing of units to capture this real world condition.

vii. Equipment for Printing and Scanning Media Other Than Paper: EPA often receives questions about qualifying products that print or scan media other than paper (e.g., cloth, microfilm, etc.) and welcomes data on their energy consumption. Such data would support development of requirements for these products in a future version of the specification.

viii. **Professional Products (High-speed TEC Products for Printing on Heavier, Larger Paper):** EPA has learned that some high-speed TEC products have additional requirements for handling larger and heavier paper. EPA will consider separating these into a separate category in a future version of the specification.

ix. **Decoupled Requirements for TEC Categories:** In Version 1 and 2 Imaging Equipment specifications, EPA has assumed that color products would have higher TEC than monochrome products due to their additional complexity, and multi-function higher than single-function. The TEC requirements were structured to reflect this relationship. However, EPA has recently learned that color MFDs—a premium product—can incorporate energy saving features that decrease their energy consumption below that for monochrome non-MFDs. EPA will therefore consider decoupling the TEC requirements in the future to recognize the highest performers among all TEC categories.